

## **REMARKS**

By this amendment, claims 1-6 and 8-13 have been amended, and claims 14-20 have been added. Thus, claims 1-20 are now active in the application. Reexamination and reconsideration of the application are respectfully requested.

The specification and abstract have been carefully reviewed and revised to make grammatical and idiomatic improvements in order to aid the Examiner in further consideration of the application. The amendments to the specification and abstract are incorporated in the attached substitute specification and abstract. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and Abstract by the current amendment. The attachment is captioned "**Version with markings to show changes made.**"

In item 1 on page 2 of the Office Action, the Examiner indicated that Figs. 9 and 10 should be labeled as "Prior Art". However, the Examiner's attention is directed to the Preliminary Amendment filed April 12, 2006, which included replacement sheets for Figs. 9 and 10 labeling Figs. 9 and 10 as "Prior Art". It has been confirmed that these replacement sheets are in fact present in the U.S. PTO Image File Wrapper (IFW). Therefore, it is respectfully requested that the Examiner indicate approval of these replacement drawing sheets.

In item 2 on page 2 of the Office Action, claims 5, 6 and 8-13 were objected to for including "any one of" in the preamble. Accordingly, each of these claims has been amended to delete "any one of."

In items 3 and 4 on pages 2 and 3 of the Office Action, claims 4, 6, 7 and 11-13 were rejected under 35 U.S.C. 112, second paragraph, as being indefinite due to the presence in claim 4 of the limitations "an upper end face" and the presence in claims 6 and 11-13 of the recitation "an annular gas passage in the sound deadening space." Regarding claim 4, the phrase "an upper end face" has been changed to --the upper end face-- so as to obviate this concern. Regarding the phrase "an annular gas passage in the sound deadening space," it is submitted that this recitation is clearly explained and properly defined in the present specification and is thus not unclear or indefinite within the meaning of 35 U.S.C. 112, second paragraph. Specifically, the Examiner's

attention is directed to the original specification, wherein the annular gas flow is explained at, for example, page 10, lines 11-17, page 13, line 22 through page 14, line 11, page 14, line 24 through page 15, line 6, and page 17, lines 9-13. The Examiner's attention is also directed to page 10, line 18 - page 11, line 15, wherein the nature of the "annular gas passage" (148) is clearly explained. In other words, as described, the annular gas passage 148 is formed in the sound deadening space 142 by proper configuration of the suction muffler 140, as well as proper location of the inlet pipe 150 and outlet pipe 152 within the sound deadening space 142. As such, it is submitted that the recitations in claims 6 and 11-13 are clearly definite within the meaning of 35 U.S.C. 112, second paragraph.

Next, in items 7-14 on pages 3-5 of the Office Action, claims 1-13 were rejected under 35 U.S.C. 102(b) as being anticipated by Ide (U.S. 6,361,290). This rejection is respectfully traversed, and is believed clearly inapplicable to the claims 1-20 as now presented, for the following reasons.

With exemplary reference to the present drawing figures, claim 1 now sets forth a hermetic compressor 100 comprising: a hermetic container 101 for storing oil 102; and a compressing element 120 accommodated in the hermetic container 101 for compressing refrigerant gas; wherein the compressing element 120 has a compression chamber 134, a cylinder 130 forming the compression chamber 134, a piston 128 inserted into the cylinder 130 for reciprocating therein, and a suction muffler 140 having one end communicating with the compression chamber 134; and wherein the suction muffler 140 has a sound deadening space 142, a gas flow forming part 144 forming a gas flow 143 flowing in a constant direction in the sound deadening space 142 by providing an opening of an inlet pipe 150 or an outlet pipe 152 at a thin part of the sound deadening space 142, and an oil discharge opening 146 provided in a downstream side of the gas flow 143 in a lower part of the sound deadening space 142.

In contrast to the present invention as set forth in present claim 1, the Ide patent, although disclosing a hermetic compressor comprising a hermetic container, and a compressing element including a suction muffler 8, does not disclose or suggest a suction muffler such as that required by present claim 1. That is, as discussed above, the suction muffler 140 of present claim 1 is

required to have a sound deadening space 142, and a gas flow forming part 144 that forms a gas flow 143 flowing in a constant direction in the sound deadening space 142 by providing an opening of an inlet pipe 150 or an outlet pipe 152 at a thin part of the sound deadening space 142. The suction muffler 140 of the present invention is also required to include an oil discharge opening 146 provided in a downstream side of the gas flow 143 in a lower part of the sound deadening space 142.

The suction muffler 8 of the Ide patent, on the other hand, is merely provided with a suction inlet hole 8a opening into a cavity inside the suction muffler 8, and a discharge outlet 8b. As described at column 12, lines 31-43 of the Ide patent, the cavity defined within the suction muffler 8 is configured to decrease the speed of the refrigerant gas flow by, for example, having partition walls to partition the cavity of the suction muffler 8 into several chambers, so that the gas flow is forced to snake through the chambers, thereby lowering the speed of the gas flow to thereby reduce the noise level of the refrigerant gas flowing out through the discharge outlet 8b. However, the inlet opening 8a and discharge outlet 8b of Ide, as well as the configuration of the cavity within the suction muffler 8 thereof, are not configured so as to form a gas flow forming part that forms a gas flow that flows in a constant direction within the cavity by providing an opening of an inlet pipe or an outlet pipe at a thin part of the sound deadening space, as required by claim 1. Rather, as mentioned, the gas flow in the Ide suction muffler cavity is not in a constant direction as required, but is snaked through multiple chambers defined by partition walls, and also, the inlet hole 8a and discharge pipe 8b do not have an opening of a thin part of a sound deadening space of the suction muffler provided so as to form a gas flow forming part that causes the gas flow to flow in a constant direction within the cavity, as specified by claim 1.

Thus, for the above-discussed reasons, it is believed apparent that the Ide patent does not anticipate claim 1. Furthermore, there is clearly no suggestion in Ide or elsewhere that would have caused a person having ordinary skill in the art to modify the Ide configuration in such a manner as to result in or otherwise render obvious the present invention of claim 1. Therefore, it is respectfully submitted that claim 1, as well as claims 2-15 which depend therefrom, are clearly allowable over the prior art of record.

Next, again with exemplary reference to the present drawing figures, new independent claim 16 sets forth a hermetic compressor 100 comprising: a hermetic container 101 for storing oil 102; a compressing element 120 accommodated in the hermetic container 101 for compressing a refrigerant gas; the compressing element comprising a cylinder 130, and a piston 128 disposed in the cylinder 130 for reciprocation, such that a compression chamber 134 is defined by the cylinder 130 and the piston 128; and a suction muffler 140 having a sound deadening space 142 therein defined within walls including a bottom wall and side walls (see Figs. 3-8); wherein the suction muffler 140 comprises an inlet pipe 150, having an internal opening that opens into the sound deadening space 142 and an external opening that opens outside the sound deadening space 142, for inlet of the refrigerant gas into the sound deadening space 142, an outlet pipe 152, having an internal opening that opens into the sound deadening space 142 and an external opening that opens outside the sound deadening space 142, for outlet of the refrigerant gas from the sound deadening space 142, the external opening of the outlet pipe 152 communicating with the compression chamber 134 of the compressing element 120, and an oil discharge opening 146 provided at a bottom part of the sound deadening space 142 adjacent one of the side walls such that oil pooled (see 146A in Fig. 3) near a junction of the bottom wall and the one of the side walls can discharge through the oil discharge opening 146, wherein at least one of the internal opening of the inlet pipe 150 and the internal opening of the outlet pipe 152 is disposed in a location within the sound deadening space 142 so as to constitute a gas flow forming part 144 that causes a flow of the refrigerant gas 143 along the bottom part of the sound deadening space 142 in a constant direction toward the oil discharge opening 146 to cause the oil 102 in the sound deadening space 142 to pool at the oil discharge opening 146 (as illustrated in Fig. 3).

This invention as now set forth in claim 16 is not disclosed or suggested by the Ide patent or the other references of record. As discussed above in support of claim 1, the configuration of the present invention and, in particular, of sound deadening space 142 of the suction muffler and arrangement of the internal openings of the inlet and outlet pipes, are such as to cause an advantageous refrigerant gas flow 143 within the sound deadening space. In particular, claim 16

specifies that at least one of the internal opening of the inlet pipe 150 and the internal opening of the outlet pipe 152 is disposed in a location within the sound deadening space 142 so as to constitute a gas flow forming part 144 that causes the flow of the refrigerant gas 143 along the bottom part of the sound deadening space 142 in a constant direction toward the oil discharge opening 146 to cause the oil in the sound deadening space 142 to pool at the oil discharge opening 146 (as illustrated in Fig. 3, with the broken lines 146A) illustrating an oil pool 102A that is created due to the unique refrigerant gas flow 143 generated by the gas flow forming part 144 constituted by at least one of the internal opening of the inlet pipe 150 and the internal opening of the outlet pipe 152 in a location within the sound deadening space 142. As discussed above, although the Ide patent discloses a hermetic compressor having a suction muffler 8, wherein the suction muffler 8 has an inlet opening hole 8a and a discharge pipe 8b, there is no disclosure or suggestion in the Ide patent of the particular configuration as required by claim 16. There is nothing in the Ide patent to suggest that the internal opening of at least one of the inlet pipe 8a and outlet pipe 8b thereof is disposed within the sound deadening space and serves to constitutes a gas flow forming part that causes the particular refrigerant gas flow along the bottom part of the cavity in a constant direction toward an oil discharge opening to cause the oil in the sound deadening space to pool at the oil discharge opening, as required by claim 16. The Ide patent briefly mentions (at column 12, line 65 - column 13, line 2) that lubrication oil flows downward along partition walls of the suction muffler 8 “and is discharged from a small hole (not shown) provided at the bottom portion of the suction muffler 8 to the bottom of the inside of the hermetic shell 1.” There is no disclosure or suggestion, however, of the particular arrangement to constitute a gas flow forming part that causes flow of the refrigerant gas along the bottom part of the sound deadening space in a constant direction toward the oil discharge opening to cause the oil in the sound deadening space to pool at the oil discharge opening, as required by claim 16.

Therefore, for the reasons presented above, it is believed apparent that the present invention of claim 16 is not anticipated by or in any way rendered obvious the Ide disclosure. There is also no disclosure or suggestion in the other references of record that would have caused

a person of ordinary skilled in the art to modify the Ide configuration in such a manner as to result in or otherwise render obvious the present invention of claim 16. Therefore, it is respectfully submitted that claim 16, as well as claims 17-20 which depend therefrom, are clearly allowable over the prior art of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is clearly in condition for allowance. An early notice thereof is earnestly solicited.

If, after reviewing this Amendment, the Examiner feels there are any issues remaining which must be resolved before the application can be passed to issue, it is respectfully requested that the Examiner contact the undersigned by telephone in order to resolve such issues.

Respectfully submitted,

Ko INAGAKI et al.

**/Charles R Watts/**

By: 2009.02.18 14:52:27 -05'00'

Charles R. Watts

Registration No. 33,142

Attorney for Applicants

CRW/asd  
Washington, D.C. 20006-1021  
Telephone (202) 721-8200  
Facsimile (202) 721-8250  
February 18, 2009

## DESCRIPTION

### HERMETIC COMPRESSOR

5           This application is a U.S. national phase application of PCT international application PCT/JP2005/022725, filed December 6, 2005.

#### Technical Field

          The present invention relates to a hermetic compressor used in a  
10   refrigerating cycle of an electric refrigerator for household and professional uses, and the like.

#### Background Art

          In recent years, a demand for global environmental protection  
becomes ~~has become~~ increasingly strong. For this reason, in ~~the refrigerator~~  
15   ~~refrigerators~~, other refrigerating cycle apparatus and the like, it is especially  
strongly desired to increase ~~especially~~ efficiency.

          Hitherto, in the hermetic compressor utilized in ~~the refrigerator~~  
~~refrigerators~~, ~~the refrigerating cycle apparatus and the like~~, there ~~is~~ has been  
used a resin-made suction muffler. These conventional hermetic  
20   compressors are disclosed in, for example, Japanese Patent Unexamined  
Publication No.H05-195953 and the like.

          Hereunder, ~~there is explained about the conventional hermetic~~  
compressor is explained while referring with reference to the drawings.

          Fig. 9 shows a longitudinal sectional view of the conventional  
25   hermetic compressor. Fig. 10 shows a perspective view of a suction muffler  
used in the conventional hermetic compressor.

          In Fig. 9 and Fig. 10, oil 202 is stored in a bottom part of hermetic

container 201 (hereafter referred to as "container 201"). Compressing member 204 (hereafter referred to as "member 204") is supported elastically with respect to container 201 by suspension spring 206.

Member 204 is constituted by motor element 210, and compressing  
5 element 220 disposed above motor element 210. Motor element 210 is constituted by stator 212 and rotor 214.

Compressing element 220 has crank shaft 221 (hereafter referred to as "shaft 221"). Shaft 221 is constituted by main shaft 222 and eccentric shaft 224. Main shaft 222 is supported rotatably with respect to bearing 227  
10 provided in block 226. Rotor 214 is fixed to main shaft 222. Additionally, shaft 221 has oil supplying mechanism 225.

Further, piston 228 is inserted so as to be capable of reciprocating with respect to cylinder 230 monolithically formed in block 226. Cylinder 230 forms, together with valve plate 232 (hereafter referred to as "plate 232"),  
15 ~~compressing~~ compression chamber 234.

A piston pin (not shown in the drawing) attached to piston 228 is inserted rotatably with respect to coupling part 236 ~~that is to constitute a~~ coupling means. Eccentric shaft 224 is inserted rotatably with respect to coupling part 236. ~~By these constitutions this construction,~~ coupling part  
20 236 couples eccentric shaft 224 and piston 228.

Cylinder head 238 ~~has covers~~ plate 232. Suction muffler 240 (hereafter referred to as "muffler 240") is retained by cylinder head 238 and plate 232 while being nipped. Muffler 240 is molded and formed by a resin such as poly-butylene terephthalate. Inside muffler 240, there is provided  
25 sound deadening space 242 whose inside face has been formed approximately like a circular cone. In a lower end of muffler 240, there is provided oil ~~discharged~~ discharge opening 246 (hereafter referred to as "opening 246").



~~By doing like this~~ In this manner, hermetic compressor 200 (hereafter referred to as "compressor 200") is constituted.

~~Next, there is explained about an operation of compressor 200~~ is explained.

5           When an electric current is applied to motor element 210, stator 212 generates a rotating magnetic field. By this rotating magnetic field, rotor 214 rotates together with main shaft 222. By the rotation of main shaft 222, eccentric shaft 224 eccentrically moves. An eccentric motion of eccentric shaft 224 is transmitted to piston 228 through coupling part 236. As a  
10       result, piston 228 reciprocates in cylinder 230. A refrigerant gas (not shown in the drawing) having returned from a refrigerating cycle (not shown in the drawing) outside container 201 is introduced into ~~compressing~~ compression chamber 234 through muffler 240. The refrigerant gas introduced into  
15       ~~compressing~~ compression chamber 234 is compressed in ~~compressing~~ compression chamber 234 by piston 228. The compressed refrigerant gas is sent again to the refrigerating cycle outside container 201.

          On the occasion of this refrigerant compression, ~~a~~ noise is generated by an intermittent suction of the refrigerant gas. Muffler 240 ~~bears a function of reducing~~ serves to reduce the generated noise. Additionally, by  
20       the fact that muffler 240 is formed by the resin whose heat transfer is small, ~~a~~ heating of the refrigerant gas is prevented. By this fact, a decrease in performance of compressor 200 is prevented.

          Additionally, by utilizing actions of a centrifugal force generated by the rotation of shaft 221, and the like, oil supplying mechanism 225 supplies  
25       oil 202 stored in the bottom part of container 201 to upper compressing element 220. Oil 202 supplied to compressing element 220 lubricates some sliding portions of bearing 227 and the like. Thereafter, oil 202 is dispersed

from an upper end of shaft 221 to the environment by the centrifugal force of main shaft 222. Dispersed oil 202 lubricates constitutional members such as piston 228 and cylinder 230. Additionally, oil 202 adheres to inside wall surface 250 of container 201, and flows down to the bottom part of container 201 along inside wall surface 250. ~~During~~ As oil 202 flows down along inside wall surface 250, a heat is conducted from oil 202 to container 201. The heat conducted to container 201 is radiated to the outside of hermetic compressor 200 through a wall surface material of container 201. By this fact, a cooling of compressor 200 is performed.

Further, oil 202 having dispersed from the upper end of shaft 221 is sucked also into muffler 240 with a flow of the refrigerant gas. The flow of the refrigerant gas is released into sound deadening space 242 in muffler 240, and its velocity decreases. When the flow velocity of the refrigerant gas decreases, oil 202 drops to a lower part of sound deadening space 242. Oil 202 having dropped into sound deadening space 242 flows down along inside wall surface 252 of sound deadening space 242. Oil 202 having flowed down collects to a lower end of sound deadening space 242. Thereafter, oil 202 having collected to the lower end of sound deadening space 242 is discharged from opening 246 to the outside of muffler 240.

However, in the above ~~constitution~~ configuration of conventional compressor 200, it is difficult to contrive a miniaturization of muffler 40-240 with an inside shape of sound deadening space 242 maintained in a shape like the circular cone. This fact hinders the miniaturization of compressor 200.

That is, in order ~~that for~~ that for muffler 240 ~~achieves to achieve~~ a sound deadening function, sound deadening space 242 necessitates a spatial volume (width or depth of sound deadening space 242) larger than a certain value.

Further, in order ~~that for~~ oil 202 ~~flows to flow~~ to opening 246 along inside wall surface 252, sound deadening space 242 is ~~the shape shaped~~ like the circular cone having an angle of a certain degree. Thereupon, for muffler 240, a height of a certain degree becomes necessary, so that opening 246  
5 approaches a liquid level of oil 202 stored in the bottom part of container 201.

However, the liquid level of oil 202 stored in the bottom part of container 201 changes by an operating state of compressor 200. Especially, at ~~a starting time~~ start-up of compressor 200, a refrigerant gas having dissolved in oil 202 bubbles out ~~by due to~~ a pressure drop in container 201.  
10 For this reason, the liquid level of oil 202 ascends, so that opening 246 is immersed in oil 202. Additionally, an average pressure in sound deadening space 242 is low in comparison with that in container 201. As a result, a large quantity of oil 202 enters ~~from through~~ opening 246 ~~to into~~ sound deadening space 242, so that oil 202 is liable to remain in muffler 240.

15 Further, it is considered to dispose opening 246 while being separated from oil 202 in the bottom part of container 201 by reducing an incline of inner wall surface 252 to thereby suppress a height of muffler 240 to a low level. However, a dropping velocity of oil 202 flowing down along inner wall surface 252 becomes slow, so the oil 202 is not discharged sufficiently from  
20 sound deadening space 242. As a result, similarly, oil 202 is liable to remain in muffler 240.

Like this, if the large quantity of oil 202 remains in muffler 240, when the refrigerant gas is sucked ~~to into~~ compressing chamber 234, oil 202 is raised, so that the large quantity of oil 202 is sucked ~~to into~~ compressing  
25 chamber 234.

If the large quantity of oil 202 flows into compressing chamber 234, a load ~~at a during compressing time~~ becomes large. As a result, an input

energy of compressor 200 increases. Or, the refrigerant gas is not compressed sufficiently, so that a refrigerating ability of compressor 200 decreases. Further, by the fact that a compressing load and the like abruptly fluctuate, the noise of the compressor 200 becomes larger.

5 | Additionally, heat exchanger performance is influenced by the fact that the large quantity of oil 202 is discharged to the refrigerating cycle,—a performance of a heat exchanger undergoes an influence.

#### Disclosure-Summary of the Invention

10 | A hermetic compressor of the present invention has a hermetic container storing an oil, and a compressing element accommodated in the hermetic container and compressing a refrigerant gas; the compressing element has a ~~compressing~~ compression chamber, a cylinder forming the compressing chamber, a piston inserted into the cylinder and reciprocating, and a suction muffler whose one end communicates with the ~~compressing~~ compression chamber; and the suction muffler has a sound deadening space, 15 | a gas flow forming part forming a gas flow flowing in a constant direction in the sound deadening space, and an oil ~~discharged~~ discharge opening provided in a downstream side of the gas flow in a lower part of the sound deadening space. By this ~~constitution~~ construction, there is realized the—a hermetic 20 | compressor in which the oil is ~~more difficult to~~ does not readily remain in the suction muffler, whose noise is lower, and whose performance is stabilized.

#### Brief Description of the Drawings

Fig. 1 is a longitudinal sectional view of a hermetic compressor in an embodiment of the present invention.

25 | Fig. 2 is a sectional view ~~by a~~ along a line 2 – 2 line of the hermetic compressor shown in Fig. 1.

Fig. 3 is a sectional view of a suction muffler used in the hermetic

compressor shown in Fig. 1.

Fig. 4 is a perspective view of the suction muffler shown in Fig. 3.

Fig. 5 is a sectional view of a suction muffler used in the hermetic compressor shown in Fig. 1.

5 Fig. 6 is a sectional view of a suction muffler used in the hermetic compressor shown in Fig. 1.

Fig. 7 is a sectional view of a suction muffler used in the hermetic compressor shown in Fig. 1.

Fig. 8 is a sectional view of a suction muffler used in the hermetic  
10 compressor shown in Fig. 1.

Fig. 9 is a longitudinal sectional view of a conventional hermetic compressor.

Fig. 10 is a perspective view of a suction muffler used in the conventional hermetic compressor.

## 15 | **Details Description of Preferred Embodiment—the Invention**

Hereunder, there is explained about an embodiment of the present invention ~~while referring is explained with reference~~ to the drawings.

(Embodiment)—

Fig. 1 is a longitudinal sectional view of a hermetic compressor in an  
20 embodiment of the present invention. Fig. 2 is a sectional view at a along  
line 2 - 2 line of the hermetic compressor shown in Fig. 1. Fig. 3 is a  
sectional view of a suction muffler used in the hermetic compressor shown in  
Fig. 1. Fig. 4 is a perspective view of the suction muffler shown in Fig. 3.

In Fig. 1 to Fig. 4, oil 102 is stored in a bottom part inside hermetic  
25 container 101 (hereafter referred to as “container 101”). Additionally, there  
is accommodated compressing member 104 (hereafter referred to as “member  
104”) inside container 101. Member 104 is constituted by motor element 110

and compressing element 120 driven by motor element 110. Member 104 is supported elastically with respect to container 101 by suspension spring 106. Further, inside container 101, there is filled a hydrocarbon refrigerant gas, such as R600a for instance, whose global warming potential is low. Further, power source terminal 108 is attached to container 101 for supplying power ~~from a power source to motor element 110 is attached to container 101.~~ By ~~doing like this~~ In this manner, hermetic compressor 100 (hereafter referred to as "compressor 100") is constituted.

First, ~~there is explained about~~ motor element 110 is described.

Motor element 110 forms a salient pole concentrated ~~winding-type~~ winding-type DC brushless motor. Motor element 110 has stator 112 and rotor 114. Motor element 110 is connected to an inverter drive circuit (not shown in the ~~drawing~~ drawings) by lead wire 109 through power source terminal 108.

Stator 112 is formed with a winding being wound around magnetic pole teeth of an iron core of stator 112 through an insulating material. The iron core of stator 112 is formed by a so-called flat-rolled electromagnetic steel sheets and strip (silicon steel plate), such as non-oriented magnetic sheets and strip (JIS C2552) for instance, whose iron loss is ~~little~~ low. For the iron core of stator 112, it is desirable to use the flat-rolled electromagnetic steel sheets and strip whose thickness is 0.7 mm or less, and whose iron loss is 7 W/kg or less. Additionally, for the iron core of stator 112, it is desirable to use the flat-rolled magnetic steel sheets and strip whose thickness is 0.35 mm, and whose iron loss is as ~~very little~~ low as 0.4 W/kg or less.

Rotor 114 is disposed inside stator 112. Rotor 114 is constituted by an iron core of rotor 114, and a permanent magnet disposed inside the iron core of rotor 114. As the permanent magnet, there is used a rare earth

magnet such as neodymium for instance. Further, rotor 114 is fixed to main shaft 122 constituting crank shaft 121 (hereafter referred to as "shaft 121"). Similarly to the iron core of stator 112, the iron core of rotor 114 is also formed with the flat-rolled electromagnetic steel sheets and strip, such as non-oriented electromagnetic sheets and strip (JIS C2552), being laminated.

Further, motor element 110 is operated ~~in~~at various frequencies between 15 r/sec (revolutions per second) and 75 r/sec by an inverter drive.

Next, ~~there is explained about details of compressing element 120~~ are explained.

10           Compressing element 120 is disposed above motor element 110.

Shaft 121 constituting compressing element 120 has main shaft 122 and eccentric shaft 124. A lower end part of main shaft 122 is immersed in oil 102 stored in the bottom part of container 101. In shaft 121, there is provided oil supplying mechanism 125 which communicates from the lower end part of main shaft 122 to an upper end part of eccentric shaft 124 and which is for supplying oil 102 to an upper part of compressing element 120. In block 126, there are provided bearing 127 and cylinder 130. Bearing 127 rotatably supports main shaft 122.

20           Piston 128 is fitted to and inserted into cylinder 130 ~~under a state so~~ as to be capable of reciprocating therein. Valve plate 132 (hereafter referred to as "plate 132") is disposed ~~in~~at an end face of cylinder 130. ~~Compressing~~ Compression chamber 134 is formed by cylinder 130 and plate 132. Piston 128 and eccentric shaft 124 are connected by coupling part 136 that ~~is~~ constitutes a coupling means.

25           Suction muffler 140 (hereafter referred to as "muffler 140") is fixed by the fact that it is supported while being nipped by plate 132 and cylinder head 138. Muffler 140 is formed by a synthetic resin, such as poly-butylene

terephthalate, that is a crystalline resin to which glass fibers have been mainly added.

Additionally, sound deadening space 142 is formed inside muffler 140. Muffler 140 has inlet pipe 150 and outlet pipe 152. ~~Inlet~~ One end of pipe 150 opens in its one end to into sound deadening space 142, and the other end of inlet pipe 150 opens in its other end into container 101. ~~Outlet~~ One end of pipe 152 opens in its one end to into sound deadening space 142, and the other end of outlet pipe 152 opens in its other end to compressing into compression chamber 134.

A back face side of muffler 140 adjoins stator 112 and block 126. Muffler 140 has an external shape extending along stator 112 and block 126.

Further, as shown in Fig. 1 and Fig. 4, lower portion 140B in a front face side of muffler 140 is thinner in its thickness than upper portion 140A in order to secure a distance from power source terminal 108. Lower portion 140B ~~is~~ has a shape whose thickness is thin which is thinner in its center part in comparison with its left and right parts. Additionally, lower surface 140C of muffler 140 is formed by a substantially horizontal face. Lower surface 140C ~~has~~ is disposed a certain distance from oil 102 stored in the bottom part of container 101.

As shown in Fig. 3 and Fig. 4, ~~in sound deadening space 142,~~ outlet pipe 152 extends in an approximately horizontal direction along a wall surface in an upper end of sound deadening space 142. A tip of outlet pipe 152 opens in the vicinity of the wall surface in the upper end of sound deadening space 142.

The refrigerant gas flows out along as gas flows 152A, 152B which are indicated by arrows of alternate long and short dash lines while passing through outlet pipe 152 from sound deadening space 142. By the flow of the



flowing-out refrigerant gas, annular gas flow 143 is generated in a clockwise direction along an outer periphery in sound deadening space 142. In other words, gas flow forming part 144 forming gas flow 143 is formed by outlet pipe 152.

5        ~~Here, by using Fig. 4, Next, there is detailedly explained about~~  
annular gas flow 143 formed inside sound deadening space 142 is explained  
in detail with reference to Fig. 4.

In Fig. 4, a tip of inlet pipe 150 opens in a horizontal direction in an approximate center inside sound deadening space 142. Inlet pipe 150 is  
10       constituted such that there is formed gas flow 150A in which the refrigerant gas flows in a direction from right to left. Further, outlet pipe 152 is disposed in a front side of an upper end part of sound deadening space 142. Outlet pipe 152 is constituted such that there is formed gas flow 152A in which the refrigerant gas flows in a direction from left to right.

15       Above inlet pipe 150, sound deadening space 142 has a space in a back face side of outlet pipe 152. Further, also below inlet pipe 150, sound deadening space 142 has a space whose depth is small. Further, at a height approximately the same as inlet pipe 150, sound deadening space 142 has a space extending in front sides of left and right. These spaces of four places  
20       in upper end, lower end, left end and right end respectively communicate with each other.

Further, inlet pipe 150 is formed monolithically with a wall surface in its back face side. Still further, in the vicinity of an opening part of inlet pipe 150 with respect to sound deadening space 142, an interstice scarcely  
25       exists between inlet pipe 150 and the wall surface in front side. Accordingly, an internal structure of sound deadening space 142 becomes a doughnut-like space in which the above-mentioned upper, lower, left and right spaces have

communicated so as to surround the opening part of inlet pipe 150. Accordingly, sound deadening space 142 forms in its inside annular gas passage 148.

5 Additionally, sound deadening space 142 has a shape whose lateral width is wide in comparison with its height. Further, lower surface 140C of sound deadening space 142 is constituted by the approximately horizontal face. In the vicinity of a bottom part of muffler 140, in other words, in a lower part of sound deadening space 142 and in a side face in a downstream side of gas flow 143, there is provided oil ~~discharged~~-discharge opening 146  
10 (hereafter referred to as "opening 146").

~~About Operations and actions of~~ hermetic compressor 100, constituted ~~like the as described above, its operations and actions are~~ explained below.

When the electric current is applied to motor element 110 by the inverter drive circuit, rotor 114 rotates together with main shaft 122 ~~by due~~  
15 to a magnetic field occurring in stator 112. With a rotation of main shaft 122, eccentric shaft 124 eccentrically rotates. An eccentric motion of eccentric shaft 124 is converted into a reciprocating motion through coupling part 136. By this fact, piston 128 reciprocates in cylinder 130. By the fact that piston 128 reciprocates in cylinder 130, the refrigerant gas in container 101 is  
20 sucked into ~~compressing~~-compression chamber 134. Additionally, the refrigerant gas is compressed in ~~compressing~~-compression chamber 134. In other words, a suction operation and a compression operation of the refrigerant gas are performed.

In a suction process of the refrigerant gas with the compression  
25 operation, the refrigerant gas in container 101 is intermittently sucked into ~~compressing~~-compression chamber 134 through muffler 140. After being compressed, the sucked refrigerant gas is sent to the refrigerating cycle (not

shown in the ~~drawing~~ drawings) provided outside container 101 through a discharge piping (not shown in the ~~drawing~~ drawings) and the like.

Muffler 140 constitutes an expansion type muffler ~~by including~~ inlet pipe 150, outlet pipe 152 and sound deadening space 142. ~~Muller-Muffler~~

5 140 has a function of reducing the noise which occurs by the intermittent suction of the refrigerant gas. Further, muffler 140 is formed by poly-butylene terephthalate resin etc. whose heat transfer is extremely small in comparison with a metal and the like. By this fact, there is prevented a temperature rise of the refrigerant gas which returns to ~~compressing~~  
 10 compression chamber 134 from the refrigerating cycle through muffler 140. The refrigerant gas which returns to ~~compressing~~ compression chamber 134 from the refrigerating cycle through muffler 140 has comparatively low ~~in its~~ temperature, so that the refrigerant gas ~~keeps~~ maintains a low temperature. As a result, a decrease in performance of compressor 100 is prevented.

15 Oil supplying mechanism 125 carries oil 102 stored in the bottom part of container 101 to the upper part of compressing element 120 by utilizing the centrifugal force obtained by a rotation of shaft 121, a viscous, frictional force occurring in a sliding part, and the like. Oil 102 carried to compressing  
 20 element 120 performs a lubrication of each of the sliding parts of main shaft 122 and eccentric shaft 124. Additionally, it is dispersed into container 101 from an upper end part of shaft 121. Dispersed oil 102 showers down on each of the sliding parts of piston 128 and cylinder 130, thereby performing the lubrication. ~~Oil~~ The temperature of oil 102 having lubricated rises as the oil 102 lubricates the sliding part ~~rises in its temperature by influences~~  
 25 parts due to the influence of a frictional heat of the sliding ~~part~~ parts, and the like. Oil 102 having risen in its temperature adheres to inside wall surface 160 of container 101. Oil 102 having adhered to inside wall surface 160

flows down to a lower part of container 101 along inside wall surface 160. During As oil 102 flows down to the lower part of container 101, a thermal energy ~~that of~~ oil 102 ~~holds~~ is radiated to the outside of container 101 through container 101, in other words, with container 101 as a heat transfer material. By this fact, This causes cooling of an inside of compressor 100 is cooled.

Additionally, one part of oil 102 having dispersed into container 101 is sucked into muffler 140 ~~from via~~ inlet pipe 150 ~~opened that opens~~ into container 101. Oil 102 having entered into muffler 140 is sucked to sound deadening space 142 through inlet pipe 150. When the refrigerant gas is sucked to sound deadening space 142 and its pressure is released, oil 102 drops to the bottom part of sound deadening space by gravity.

As shown in Fig. 3 and Fig. 4, by the velocity of the refrigerant gas flowing to outlet pipe 152, the refrigerant gas in sound deadening space 142 is energized and, in the back face side of outlet pipe 152, gas flow 143A ~~flowing flows~~ from left to right ~~occurs~~. Further, annular gas passage 148 is formed in sound deadening space 142. By these facts, there occur gas flow 143B, gas flow 143C and gas flow 143D, so that annular gas flow 143 cycling in sound deadening space 142 is formed. Gas flow 143B is a gas flow which flows, in a right side of sound deadening space 142, ~~from above to below in~~ downwardly at a front side of inlet pipe 150. Further, gas flow 143C is a gas flow which flows, in a lower end of sound deadening space 142, from right to left. Additionally, gas flow 143D is a gas flow which flows, upwardly in a left side of sound deadening space 142, ~~from below to above~~.

Oil 102 having dropped to the bottom part of sound deadening space 142 is conveyed to a vicinity of opening 146 by gas flow 143C. Oil 102 conveyed to the vicinity of opening 146 becomes oil pool 102A which seals

opening 146. As shown by broken line 146A in Fig. 3, a liquid level of oil pool 102A ~~becomes~~ attains an oblique slanting face ~~by~~ due to gas flow 143C.

As to a pressure in muffler 140, a negative pressure and a positive pressure alternately occur with respect to a pressure in container 101. In other words, muffler 140 is respiring. For this reason, through opening 146, there are alternately repeated a process in which oil 102 is discharged from muffler 140 to container 101 and a process in which the refrigerant gas is sucked from container 101 into muffler 140. By this fact, oil 102 having collected ~~to~~ in the vicinity of opening 146 is intermittently discharged into container 101.

As a result, oil 102 ~~is difficult to~~ does not readily remain in muffler 140, so that there is no fact that a large quantity of oil 102 remains in muffler 140. The large quantity of oil 102 is prevented from being sucked to compressing chamber 134.

The refrigerant gas in sound deadening space 142 is energized by gas flow 152A of the refrigerant gas flowing out through outlet pipe 152, so that annular gas flow 143 is formed in the inner circumference of sound deadening space 142. In other words, gas flow forming part 144 forming gas flow 143 is constituted by outlet pipe 152 which opens in the approximately horizontal direction along the wall surface in the upper end of sound deadening space 142. Accordingly, there is no necessity to add such a particular component as to provide, e.g., a special fan for generating gas flow 143C. In other words, gas flow forming part 144 is constituted without an accompanying ~~an~~ increase in cost.

Further, at ~~the starting time~~ start-up of compressor 100, it may occur that a non-gasified liquid-like refrigerant flows into compressor 100 from the refrigerating cycle. Further, it may also occur that the pressure in container

101 abruptly decreases and thus the refrigerant gas having dissolved in oil 102 bubbles out. By these facts, it may occur that oil 102 and the liquid-like refrigerant flow into muffler 140, drop into sound deadening space 142 by gravity, and remain in the bottom part of sound deadening space 142.

5           However, outlet pipe 152 is provided near an upper end face of sound deadening space 142 and sufficiently separated from lower surface 140C. For this reason, even if certain quantities of oil 102 and the liquid-like refrigerant are accumulated in the bottom part of sound deadening space 142, oil 102 and the liquid-like refrigerant are prevented from being sucked in  
10 | large quantities ~~to compressing into~~ compression chamber 134 through outlet pipe 152. As a result, there are prevented an occurrence of the noise from compressor 100, and ~~breakages~~ breakage of components of compressor 100, such as a valve (not shown in the ~~drawing~~ drawings).

          Further, lower surface 140C of sound deadening space 142 is  
15 | constituted by the approximately horizontal face. Additionally, opening 146 is disposed near an end part in a downstream side of gas flow 143C in the vicinity of lower surface 140C. By these facts, a dimension in a height direction is suppressed to a small value and, also in muffler 140, a volume of sound deadening space 142 is secured and a certain distance is secured  
20 | between opening 146 and oil 102 stored in the bottom part of container 101.

          The pressure in container 101 abruptly decreases at the ~~starting time~~  
| start-up of compressor 100, and the refrigerant gas having dissolved in oil 102 bubbles out, so that the liquid level of oil 102 may be raised. Even if the liquid level of oil 102 has raised, ~~it is prevented that~~ oil 102 and the  
25 | liquid-like refrigerant ~~flow~~ are prevented from flowing into muffler 140 ~~from~~ via inlet pipe 150 and opening 146. For this reason, oil 102 and the liquid-like refrigerant are prevented from being sucked in ~~the large quantity~~

to ~~compressing into~~ compression chamber 134. By this fact, the occurrence of the noise is prevented and, at the same time, a performance of compressor 100 is stabilized.

Further, motor element 110 is the salient pole concentrated  
 5 | ~~winding-type~~ winding-type DC brushless motor, and is smaller in its dimension in the height direction than a distributed winding induction motor. Accordingly, the dimension in the height direction is suppressed to a small value while a certain content volume of muffler 140 ~~being~~ is secured. Additionally, oil 102 is prevented from remaining inside muffler 140. By this  
 10 | fact, the noise of compressor 100 is reduced, and the performance of compressor 100 is stabilized. ~~Together with it, the,~~ while miniaturization of compressor 100 is achieved.

Especially, with motor element 110 in which a rare earth magnet capable of obtaining a strong magnetic force is used, there is realized  
 15 | compressor 100 in which the dimension in the height direction is additionally suppressed to a small value. Accordingly, even if the height of muffler 140 is low, there ~~remarkable~~ remarkably appears an advantage that a residence of oil 102 in muffler 140 is prevented. As a result, the height of compressor 100 is additionally suppressed to the small value.

20 | Further, the centrifugal force acts on annular gas flow 143 formed in sound deadening space 142. By this fact, oil 102 contained in the refrigerant gas is centrifugally separated. Oil 102 centrifugally separated adheres to inside wall surface 162 of sound deadening space 142 and flows down to the bottom part of sound deadening space 142 along inside wall surface 162. For  
 25 | this reason, an inflow of oil 102 ~~to compressing into~~ compression chamber 134 is additionally suppressed. As a result, ~~the~~ noise is additionally reduced, and the performance of compressor 100 becomes additionally stable.

Further, annular gas flow 143 is formed in sound deadening space 142. By this fact, gas flow 143C is ~~difficult to be~~ not readily disturbed, and stable, strong gas flow 143C in a constant direction is formed. Stable and strong gas flow 143C in the constant direction additionally ensures the flow of oil 102 discharged from muffler 140 through opening 146.

There is provided a visor 156 protruding like an eaves, in an upper side of opening 146. If a large quantity of oil 102 adheres to an outer surface of muffler 140 near opening 146, ~~it is easy that oil 102 is~~ could be sucked into muffler 140 from opening 146. By this fact, there is a possibility that a large quantity of oil 102 accumulates in muffler 140. However, by the fact that visor 156 is provided, oil 102 flowing down along the outer surface of muffler 140 is prevented from accumulating around opening 146. As a result, there is avoided the suction of oil 102 from an outside to an inside of muffler 140 through opening 146.

Additionally, compressor 100 is operated in a number of revolutions of a wide range with an inverter control used. For this reason, a quantity of the dispersion of oil 102 from shaft 121 greatly changes by the number of revolutions. However, in a high rotation operation in which the large quantity of oil 102 disperses and oil 102 is liable to be sucked ~~to~~ into muffler 140, gas flows 143, 143C in sound deadening space 142 become strong as well. For this reason, oil 102 having accumulated in the bottom part of sound deadening space 142 is liable to collect ~~to~~ in a vicinity of opening 146. As a result, a discharge of oil 102 from muffler 140 through opening 146 is expedited, so that there is prevented an abnormal increase of oil pool 102A in muffler 140.

Additionally, by the fact that a flow velocity of annular gas flow 143 increases, the centrifugal force applied to the refrigerant gas in sound



deadening space 142 increases. As a result, a centrifugally separating ability with respect to oil 102 contained in the refrigerant gas additionally increases as well.

Accordingly, even if compressor 100 is operated in a wide operation  
 5 | range, there is prevented the suction of oil 102 ~~to compressing into~~  
 | compression chamber 134. As a result, the performance of compressor 100 is  
 | stabilized.

There is ~~explained about a constitution in which opening~~ Opening 146  
 | ~~is has been described as being provided in a side face of muffler 140.~~  
 10 | However, there may be a ~~constitution construction~~ in which ~~it the opening is~~  
 | provided in the bottom part or lower surface 140C of muffler 140.

~~In the above explanation, there has been explained about the~~  
 | ~~constitution in which gas~~ Gas flow forming part 144 is has been described as  
 | being formed by outlet pipe 152 which is opened opens into sound deadening  
 15 | space 142 while being extended extending in the approximately horizontal  
 | direction along the wall surface in the upper end of sound deadening space  
 | 142. However, the gas flow forming part 144 is not necessarily limited to  
 | outlet pipe 152 ~~which is opened while being extended extending in the~~  
 | approximately horizontal direction along the wall surface in the upper end of  
 20 | sound deadening space 142.

For example, as shown in Fig. 5, gas flow forming part 144 may be  
 | constituted by inlet pipe 150 which ~~is opened opens into sound deadening~~  
 | space 142 while being extended extending in the approximately horizontal  
 | direction along the wall surface in a lower end of sound deadening space 142.

25 | Further, as shown in Fig. 6, gas flow forming part 144 may be  
 | constituted by outlet pipe 152 which ~~is opened opens into sound deadening~~  
 | space 142 while being extended extending in the approximately horizontal

direction along the wall surface in the lower end of sound deadening space 142. Further, gas flow forming part 144 may be constituted by inlet pipe 150 which ~~is opened~~ opens into sound deadening space 142 while ~~being extended~~ extending in the approximately horizontal direction along the wall surface in the upper end of sound deadening space 142.

Additionally, as shown in Fig. 7, gas flow forming part 144 may be constituted by outlet pipe 152 which ~~is opened~~ opens into sound deadening space 142 while ~~being extended~~ extending in an approximately vertical direction along the wall surface in a left end of sound deadening space 142. Further, gas flow forming part 144 may be constituted by inlet pipe 150 which ~~is opened~~ opens into sound deadening space 142 while ~~being extended~~ extending in the approximately vertical direction along the wall surface in a right end of sound deadening space 142.

Furthermore, as shown in Fig. 8, gas flow forming part 144 may be constituted by outlet pipe 152 which ~~is opened~~ opens into sound deadening space 142 while ~~being extended~~ extending in the approximately vertical direction along the wall surface in the right end of sound deadening space 142. Further, gas flow forming part 144 may be constituted by inlet pipe 150 which ~~is opened~~ opens into sound deadening space 142 while ~~being extended~~ extending in the approximately vertical direction along the wall surface in the left end of sound deadening space 142.

In other words, by the fact that gas flow forming part 144 is constituted by ~~any~~ either one or both of outlet pipe 152 and inlet pipe 150, the inflow of oil 102 to ~~compressing~~ compression chamber 134 is suppressed without additionally providing a special member. As a result, there is provided compressor 100 whose noise is low and which realizes a stable operation.

Further, outlet pipe 152 and inlet pipe 150 may be provided while being respectively extended along any end face of the upper end face, the lower end face, the left end face and the right end face of sound deadening space 142. In other words, it suffices if it is a constitution in which, in order  
 5 to form annular gas flow 143 in sound deadening space 142, an energizing force for forming gas flow 143 is given to the refrigerant gas in sound deadening space 142.

Like the ~~As discussed~~ above, in compressor 100, oil 102 is certainly discharged from muffler 140, and thus prevented from being sucked to  
 10 ~~compressing into compression~~ chamber 134. As a result, the performance of compressor 100 becomes stable, and ~~the occurrence of the~~ noise is suppressed as well.

#### Industrial Applicability

Like the ~~As discussed~~ above, in the hermetic compressor, since the  
 15 performance of the compressor is stable and the noise is reduced, ~~there is the~~ hermetic compressor can be widely applied to an air conditioner, a vending machine, other refrigerating apparatus and the like, and is not limited to ~~the~~ use in a household electric refrigerator for household.

## ABSTRACT

A hermetic compressor has a hermetic container storing an oil, and a compressing element accommodated in the hermetic container and compressing a refrigerant gas; the gas. The compressing element has a  
5 ~~compressing~~ compression chamber, a cylinder forming the ~~compressing~~ compression chamber, a piston inserted into the cylinder and ~~reciprocating~~ for reciprocation, and a suction muffler (140) whose one end communicates with the ~~compressing chamber~~ and the compression chamber. The suction muffler (140) has a sound deadening space (142), a gas flow forming part  
10 (144) forming a gas flow (143) flowing in a constant direction in the sound deadening space (142), and an oil ~~discharged~~ discharge opening (146) provided in a downstream side of the gas flow (143) in a lower part of the sound deadening space (142). By this ~~constitution~~ construction, there is realized the ~~a~~ hermetic compressor in which the oil is ~~more difficult to~~ does  
15 not readily remain in the suction muffler (140), whose noise is lower, and whose performance is stabilized.